What is the relationship between the intake of milk and milk products and body weight?

Conclusion

Strong evidence demonstrates that intake of milk and milk products provide no unique role in weight control.

Grade: Strong

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

Evidence Summary Overview

The Committee reviewed 18 studies conducted since 2004 that examined the link between the intake of milk and milk products and body weight and concluded that evidence supporting the hypothesis of a relationship between intake of milk and milk products and decreased body weight is not convincing. This conclusion is based on one systematic review (Lanou, 2008), one randomized controlled trial (RCT) (Bowen, 2005), four prospective cohort studies (Rajpathak, 2006; Rosell, 2006; Snijder, 2008; Vergnaud, 2008) and eight cross-sectional studies (Azadbakht, 2005; Beydoun, 2008; Brooks, 2006; Houston, 2008; Marques-Vidal, 2006; Mirmirin, 2005; Murakami, 2006; O'Neil 2009). The Committee also reviewed three studies that looked at energy intake as an outcome (Dove, 2009; Harper, 2007; Hollis, 2007) and one study (Olsen, 2007) that addressed pregnancy.

Lanou et al (2008) reviewed the body of evidence on the effect of dairy product or calcium intake, with or without energy restriction, on body weight or adiposity. Of the 49 randomized clinical trials reviewed, 42 found no effect on weight of dairy or calcium consumption and only four trials showed a potential effect of dairy products or calcium on weight loss. Of the 16 clinical trials, 15 showed no difference in body fat change between consumers of high and low levels of dairy or calcium. One study found greater fat loss among high-dairy consumers compared to low-dairy consumers. Overall, their review does not support a connection between dairy or calcium consumption and weight or fat loss.

In the Bowen et al (2005) RCT, the effects on weight, body composition, metabolic parameters and risk markers of two isocaloric, energy-restricted high-protein (PRO) diets that differed in dietary calcium and PRO source on weight loss and body composition in healthy, overweight adults were compared. The authors concluded that weight loss following energy-restricted, high-PRO diets is not affected by dietary calcium or PRO source.

The following four prospective cohort studies did not strongly support the hypothesis that increasing milk and milk products would result in a decrease in weight. Rajpathak et al (2006) evaluated the association between calcium and dairy intakes and 12-year weight change among men in the US. Their results indicate that increasing calcium or dairy consumption is not associated with lower long-term weight gain in men. Rosell et al (2006) examined the association between changes in dairy product consumption and self-reported weight change over nine years among women. They concluded that the association between the intake of dairy products and weight gain differed according to the type of dairy product and the body weight status at baseline. Snijder et al (2008) investigated the association between dairy consumption and 6.4-year changes in weight and metabolic disturbances in an elderly Dutch population. They concluded that higher dairy consumption does not protect against weight gain and the development of metabolic disturbances over time. Vergnaud et al (2008) investigated the relationship between dairy consumption and calcium intake with six-year changes in body weight and waist circumference (WC) in a French population. The authors concluded that sex, overweight status at baseline and type of dairy product influences the associations between dairy product consumption and anthropometric changes. Eight cross-sectional studies (Azadbakht, 2005; Beydoun, 2008; Brooks, 2006; Houston, 2008; Marques-Vidal, 2006; Mirmirin, 2005; Murkami, 2006; O'Neil, 2009) were reviewed, and were more likely to support that calcium and dairy consumption was related to lower BMI.

Other studies included in the review measured whether consumption of milk or milk products was related to energy intake as an outcome. Dove et al (2009) concluded that consumption of skim milk, in comparison with a fruit drink, leads to increased perceptions of satiety and to decreased energy intake at a subsequent meal. Harper et al (2007) conducted a randomized cross-over design study to compare the effect on appetite and energy intake of consuming either a sugar-sweetened beverage (cola) or chocolate milk drink. The authors concluded that consuming chocolate milk increased subjective ratings of satiety and fullness compared with cola and decreased hunger and later consumption of food. However, this enhanced satiety did not translate into differences in ad libitum energy intake. Hollis and Mattes (2007) assessed the effect of daily intake of one or three portions of dairy foods on energy intake and appetite. The authors concluded that increasing dairy consumption from one to three portions each day led to increased energy intake. Thus, dairy foods may have some benefit for satiety when compared to fruit drinks, but increased consumption of any extra calories (vs. substitution), including dairy products, will lead to increased energy intake.

Olsen et al (2007) examined whether milk consumption during pregnancy is associated with greater infant size at birth in the Danish National Birth Cohort. Milk consumption was inversely associated with the risk of small-for-gestational age birth and directly with both large-for-gestational age birth and mean birth weight.

Evidence Summary Paragraphs

Systematic Review

Lanou et al, 2008 (neutral quality) performed a systematic review to evaluate the body of evidence on the effect of dairy product or calcium intake, with or without energy restriction, on body weight or adiposity. Forty-nine studies were identified using a MEDLINE search (keywords: milk, dairy, calcium, weight, body mass index (BMI), body fat) of clinical trials published between 1966 and 2007. Eighteen studies examined the effect of dairy products (seven studies; 330ml to four servings a day; three months to two years in length; N=28 to 757) or calcium (11 studies; 300 to 1,200mg calcium a day; six months to three years in length; N=84 to 162) in the absence of energy restriction in children and adolescents, and 20 studies examined the effect of dairy products (10 studies; 12 weeks to three years in length; N=34 to 204) or calcium (10 studies; 1,000 to 1,200mg calcium a day; four months to seven years in length; N=37 to 36,282) in the absence of energy restriction in adults. Of these 38 studies, 37 showed no effect of dairy product or calcium intake in the absence of energy restriction on weight in adults or children. Eleven studies examined the effect of dairy products (500 to 2,400mg calcium a day or two to four servings a day; 12 to 48 weeks in length; N=29 to 72) or calcium (1,200mg to 1g calcium a day; one month to 25 weeks in length; N=62 to 100) with energy restriction in adults. Of these studies, seven found no effect and four found a significant positive association between dairy or calcium and weight loss. In summary, of the 49

RCTs reviewed, 42 found no effect on weight of dairy or calcium consumption, and only four trials showed a potential effect of dairy products or calcium on weight loss. In addition, 15 of 16 clinical trials showed no difference in body fat change between high and low consumers of dairy or calcium, while one study found greater fat loss among high-dairy consumers compared to low-dairy consumers. The authors conclude that the current evidence does not support the hypothesis that dairy or calcium consumption results in weight or fat loss.

Randomized Controlled Trial

Bowen et al, 2005 (positive quality) conducted an RCT in Australia to compare the effects on weight, body composition, metabolic parameters and risk markers of two isocaloric, energy-restricted high-PRO diets that differ in dietary calcium and PRO source on weight loss and body composition in healthy, overweight adults (N=50, 30 women and 20 men, ages 25 to 64 years). The intervention diets were a high dairy PRO/high-calcium (DP, 2,400 mg calcium a day) diet and a high mixed PRO/moderate calcium (MP, 500mg calcium per day) diet followed for a 12-week energy restriction phase, followed by a four-week energy balance phase. After 16 weeks, subjects showed significant reductions in total weight (-9.7±3.8 kg), fat mass (-8.3±0.4kg) and lean mass (-1.6±0.3kg), but there were no significant (NS) differences between the two diet groups. The authors concluded that weight loss following energy-restricted, high-protein diets is not affected by dietary calcium or PRO source.

Prospective Cohort Studies

Rajpathak et al, 2006 (positive quality) used data from a prospective cohort study (Health Professionals Follow-up Study) to evaluate the association between calcium and dairy intakes and 12-year weight change in US men. For this study, dietary intake during the preceding year was assessed in 1986 obtained using a food-frequency questionnaire (FFQ), which also collected information on the use of calcium and multivitamin supplements. Weight change follow-up was calculated using self-reported body weights given in 1986 and 1998. Data from 19,615 men (ages 40 to 75 years; mean BMI=25.2kg/m^2) was included in the final analysis. Results of a multivariate analysis adjusted for potential confounders showed that neither baseline nor change in total calcium intake was significantly associated with weight change. There was NS association between weight and dietary, dairy or supplemental calcium when each calcium source was evaluated separately. Men with the largest increase in total dairy intake gained slightly more weight (3.14±0.11kg) than did men with the largest decrease in dairy intake (2.57±0.13kg) ($P<0.001$). However, this association was primarily due to an increase in high-fat dairy intake ($P<0.001$), as low-fat dairy intake was not significantly associated with weight change ($P=0.19$). These results do not support the hypothesis that increasing calcium or dairy consumption is associated with lower long-term weight gain in men.

Rosell et al, 2006 (positive-quality), a prospective cohort study conducted in Sweden (Swedish Mammography Cohort), examined the association between changes in dairy product consumption and self-reported weight change over nine years. In 1987, dietary intake was measured with a 67-item FFQ, and in 1997 it was measured with an extended 96-item FFQ. 38,984 women completed the follow-up questionnaire; after application of exclusion criteria, 19,352 women (mean age 46.3±4.5 years at baseline) were included in the analysis. Women were divided into four dairy product consumption groups: 1) less than one serving a day, no change at follow-up; 2) less than one serving a day, increased to more than one serving a day at follow-up; 3) more than one serving a day, no change at follow-up; and 4) more than one serving a day, decreased to less than one serving a day at follow-up. Mean BMI at baseline was 23.7±3.5kg/m^2, and mean weight gain in the cohort was 0.33±0.63kg per year. Consistent consumption of more than one serving of dairy products per day was inversely associated with weight gain; odds ratios (OR) for consumption of less than one serving per day of whole milk and sour milk was 0.85 (95% CI: 0.73, 0.99) and of cheese was 0.70 (95% CI: 0.59, 0.84), while NS associations were seen for the other three intake groups. The authors concluded that the association between the intake of dairy products and weight gain differed according to the type of dairy product and to the body weight status at baseline.

Snijder et al, 2008 (positive quality), a prospective cohort study conducted in the Netherlands (Hoorn Study), investigated the association between dairy consumption and 6.4-year changes in weight and metabolic disturbances, based on data from a population-based cohort of white men and women aged 50 to 75 years. Average food intake was measured at baseline using a 92-item semi-quantitative FFQ. At baseline and follow-up, participants underwent an extensive physical examination and a blood sample was drawn for biochemical analyses of fasting glucose, post-load glucose, high-density lipoprotein (HDL-C) and low density lipoprotein cholesterol (LDL-C) and triglycerides (TG). During the physical examination, weight, waist circumference (WC) and blood pressure (BP) were measured. A total of 1,124 participants were included in the analysis. Linear regression analyses, using the continuous dairy variable as independent variable and the change in body composition or metabolic variables as dependent variables, revealed that baseline dairy composition was not associated with changes in body composition or metabolic variables, neither after adjustment for potential confounders. In subjects with BMI less than 25kg/m^2, higher dairy consumption was significantly associated with an increase in BMI, waist and weight (data not shown). The authors concluded that their results do not support the hypothesis that a higher dairy consumption protects against weight gain and development of metabolic disturbances in a Dutch elderly population.

Vergnaud et al, 2008 (positive quality), a prospective cohort study conducted in France, investigated the relationship between dairy consumption and calcium intake with six-year changes in body weight and WC. At total of 13,017 subjects were recruited in 1994 and 1995 to participate in the Supplementation en Vitamines et Mineraux Antioxidants (SU.VI.MAX) Study, an RCT of daily antioxidant supplementation. A total of 2,267 subjects (1,022 women, mean age 50.8±4.3 years, 1,245 men, mean age 51.5±4.44 years) were included in the analysis. Anthropometric measurements were taken at the first (1995 to 1996) and last (2001 to 2002) clinical examinations, and at least six 24-hour dietary records during the first 18 months were evaluated. In overweight men only, six-year changes in weight and WC were inversely associated with the dairy product consumption, especially milk (P=0.02 for both weight and WC changes) and yogurt (P=0.01 for weight change, P=0.03 for WC change). Positive relations were found between milk consumption and WC change in overweight women, and between yogurt consumption and weight change in normal-weight women. The authors concluded that the associations between dairy product consumption and anthropometric changes differed according to sex, overweight status at baseline and type of dairy product.

Cross-Sectional Studies

Azadbakht et al, 2005 (positive quality), a cross-sectional study conducted in Tehran, Iran, ascertained the relation between dairy consumption and metabolic syndrome in a population-based sample of adults. A representative sample of 1,476 participants was randomly selected from the Tehran Lipid and Glucose Study, including 861 subjects aged 18 to 74 years. After application of exclusion criteria, 827 subjects (357 men, 470 women) were included in the analysis. Dairy consumption was assessed through a 168-item semi-quantitative FFQ, and subjects were categorized into quartiles of intake. Measurements relevant to the diagnosis of the metabolic syndrome were taken, such as height, weight, WC, BP and fasting blood samples for glucose and lipid concentrations. Mean consumption of milk, yogurt and cheese was 0.7±0.2, 1.06±0.6, and 0.9±0.3 servings per day, respectively; butter and ice cream were not included in the analysis due to their high fat content. Participants in the fourth quartile of dairy intake (more than 3.1 servings per day) had a lower BMI than did those in the three lower quartiles (P<0.01). Subjects in the highest quartile of dairy consumption had lower odds of having enlarged WC (OR by quartile: 1, 0.89, 0.74, 0.63, P for trend <0.001). These values became weaker after adjustment for calcium intake. The authors concluded that they found evidence of an inverse relation between dairy consumption and metabolic syndrome.

Beydoun et al, 2008 (positive quality), a cross-sectional analysis of merged National Health and Nutrition Examination Survey (NHANES) data from 1999 to 2004 in the US, assessed the association between consumption of dairy and related nutrients and obesity, central obesity and the metabolic syndrome. Out of 17,061 subjects over age 18 years (8,970 women and 8,091 men) with complete demographic data, 4,519 subjects had complete data on dietary intake (assessed from 24-hour recall data) and metabolic outcomes, such as weight, height, WC, BP and laboratory values (fasting blood glucose (FBG), triacylglycerol (TG) stores and HDL-C). Sample sizes ranged from 4,519 for metabolic syndrome to 14,618 for obesity. Multivariate logistic regression models suggested that there was an overall net increase of 5% in prevalence of central obesity for each dairy serving among men (P<0.10). Whole milk was weakly and negatively associated with the prevalence of central obesity, whereas low-fat milk had the opposite effect (P<0.05 for both). Yogurt was associated with reducedBMI and waisWC (P<0.05 for both); in contrast, cheese was positively associated with BMI and WC (P<0.05 for both). In addition, large ethnic disparities existed for intakes of dairy and calcium, and for all metabolic outcomes, leading the authors to conclude that the health effects of dairy products and related nutrients are complex and may not be uniform across the population.

Brooks et al, 2006 (positive quality), a cross-sectional analysis of data from the Bogalusa Heart Study in the US, examined the association between intake of calcium and dairy products and overweight and obesity in a biracial sample of 1,306 young adults (374 white males, 578 white females, 131 black males, 223 black females, mean age 29.7 years). Calcium intake and low-fat dairy product consumption was assessed through the Youth and Adolescent Questionnaire, a self-administered, semi-quantitative FFQ, and overweight status was measured through BMI, waist-hip ratio (WHR) and WC. Intakes of dairy products were significantly higher among blacks than whites (P<0.05), and females had significantly lower intakes of dairy products than males (P<0.05). No significant associations were found between dairy product consumption, calcium intake and overweight, defined by BMI or WC; however, in white males, there was a significant inverse association between calcium intake, low-fat dairy product consumption and WHR.

Houston et al, 2008 (positive quality), a cross-sectional study conducted in the US, examined the association between the frequency of cheese consumption and several cardiovascular risk factors, including measures of body fat, blood lipids, BP and blood glucose, using data from NHANES III. A total of 10,872 participants, aged 25 to 75 years, had complete data and were included in the analysis. Cheese consumption (combined full and low-fat) was assessed through FFQ asking one question about cheese and two questions about the consumption of foods containing large amounts of cheese. Body mass index and WC were significantly higher among men (P<0.05), but not among women, in the highest cheese consumption category (30 + servings a month) compared to non-consumers. More frequent cheese consumption was associated with a slightly worse body composition in men; however, there appeared to be less of an association between consumption and body composition in women.

Marques-Vidal et al, 2006 (neutral quality), a cross-sectional study conducted in Portugal, assessed the relationship between milk intake and BMI status using a representative population sample from the Portuguese National Health Interview Survey 1998 to 1999 database. Average daily milk intake was calculated by a FFQ that also assessed the average volume of one serving; height and weight were self-reported. A total of 37,513 subjects were included in the analysis (17,771 males, mean age 47.8 years and 19,742 females, mean age 50.3 years). In men, milk intake was inversely related to BMI (R=-0.10, P<0.001), whereas the relationship in women was weaker (R=-0.06, P<0.001). After adjustment for confounding variables, milk intake decreased with increasing BMI (P<0.001). The authors concluded that increased milk intake and possible calcium consumption is slightly but significantly inversely related to BMI.

Mirmirin et al, 2005 (neutral quality) analyzed data from a cross-sectional study to assess the relationship between consumption of dairy products and BMI in Tehranian adults. Daily dairy consumption was determined using 24-hour dietary recalls and a FFQ. Subjects were stratified into four quartiles based on dairy intake: 1) Less than 1.6 servings a day; 2) 1.6 to less than 2.2 servings a day; 3) 2.2 to less than three servings a day; and 4) more than three servings a day. The sample included 462 healthy subjects, 223 men (38±15 years; 24.8±4.6kg/m^2) and 239 women (32±13 years; 25.3±5.3kg/m^2). Mean consumption of dairy products was 3.7±1.0 and 2.9±1.2 servings per day in men and women, respectively. There was a significant inverse correlation between the servings of dairy consumed per day and BMI after controlling for age, physical activity, energy, carbohydrate (CHO), dietary fiber, PRO and fat intake (R=-0.38, P<0.05). Also, after adjustment for potential confounding variables, men and women in the top quartile of dairy consumption had lower chances for being overweight (OR=0.78; 95% CI=0.43, 0.92 for men and OR=0.89; 95% CI=0.53, 0.95 for women) and obese (OR=0.73; 95% CI=0.40, 0.83 for men and OR=0.69; 95% CI=0.34, 0.80 for women) compared to those in the first quartile. These results suggest an inverse relationship between dairy consumption and BMI.

Murakami et al, 2006 (positive quality), analyzed data from a cross-sectional study to examine the associations between dairy product and calcium intake and BMI in young Japanese women. Dietary habits during the previous month were assessed by using a validated, self-administered diet history questionnaire (DHQ). Body weight and height were self-reported as part of the DHQ. Analyses included 1,905 women, ages 18 to 20 years, with a mean BMI of 20.8±2.6 kg/m^2. Mean estimated intakes were 268±93mg per 1,000kcal for calcium and 80±63g per 1,000kcal for dairy products. There were NS associations between BMI and calcium or dairy product intake in this study. Therefore, intakes of calcium and dairy products may not necessarily be associated with BMI among young Japanese women. However, the population used in this study was relatively lean with a relatively low intake of calcium and dairy products.

O'Neil et al, 2009 (positive quality) used cross-sectional data to assess the association of milk and sweetened beverage consumption with weight, nutrient intake and dietary adequacy in a multiethnic population of Head Start mothers in the US. Dietary intake was assessed via three 24-hour dietary recalls, and nutrient intakes from foods and beverages were determined from the averages of the three days of dietary recalls. Height and weight was measured twice on each participant and BMI was calculated from these values. Subjects included 609 women (30.0±0.2 years; 30.8±0.3kg/m^2), 58% had completed high school or less and 46% were married. 33% were Hispanic, 43% were African American and 24% were white. Subjects were divided into groups based on beverage consumption: 1) Low milk, highly sweetened beverage (N=170); 2) High milk, low sweetened beverage (N=170); 3) Low milk, low sweetened beverage (N=134); 4) High milk, highly sweetened beverage (N=135). Mean BMI did not differ between the four beverage consumption groups. However, women in the high milk, low sweetened beverage group had higher mean intakes of vitamins A, D, and B$_6$; riboflavin; thiamin; folate; phosphorus; calcium; iron; magnesium; and potassium (P<0.0125) when compared with the other beverage consumption groups. Thus, Mean Adequacy Ratio (a measure of overall dietary adequacy) was highest in the high milk, low sweetened beverage (71.8±0.8) and lowest in the low milk, highly sweetened beverage (58.4±0.8) consumption groups (P<0.0125). In a multiethnic, low-income population of women, differing patterns of milk and sweetened beverage consumption were not associated with weight status.

Energy Intake as Outcome

Dove et al, 2009 (positive quality), a randomized study with crossover design conducted in Australia, investigated the effects of drinking skim milk in comparison with a fruit drink at breakfast on self-reported post-meal satiety and energy intake at lunch. Participants consumed 600ml (1,062kJ each) of either skim milk or fruit drink with a fixed-energy breakfast (1,923kJ). Participants completed visual analog scales (VAS) ratings of their satiety before breakfast (T=0), throughout the morning (T=30, 60, 120, 180, 210 and 240 minutes), and immediately after lunch (T=270 minutes). Lunch was provided four hours after breakfast (T=240 minutes). Thirty four subjects (13 men, 21 women; age 55.1±12.5 years; mean BMI=32.4±3.4kg/m^2) participated. Participants consumed significantly less energy at lunch after consuming skim milk (mean: 2,432kJ; 95% CI: 2,160, 2,704kJ) than after consuming the fruit drink (mean: 2,658kJ; 95% CI: 2,386, 2,930kJ), with a mean difference of approximately 8.5% (P<0.05). Ratings of satiety were higher throughout the morning after consumption of skim milk than after consumption of the fruit drink (P<0.05) with the differences becoming larger over the four hours (P<0.05). The authors concluded that consumption of skim milk, in comparison with a fruit drink, leads to increased perceptions of satiety and to decreased energy intake at a subsequent meal.

Harper et al, 2007 (positive quality) conducted a randomized cross-over design study to compare the effect on appetite and energy intake of consuming either a sugar-sweetened beverage (cola) or chocolate milk drink. This study was conducted in Denmark. The test drinks were 500ml cola or chocolate milk (both 900kJ), and were ingested 30 minutes before an ad libitum lunch. Visual analogue scales were used to record subjective appetite ratings every 30 minutes on each of two test days. Energy intake at lunch was calculated using weighed food intakes. Subjects were 22 men with a mean age of 23±1.8 years, and a mean BMI of 22.2±1.5kg/m^2. Satiety and fullness ratings were significantly greater (P=0.0007, P=0.0004, respectively) 30 minutes after chocolate milk than after cola. Ratings of prospective consumption and hunger were significantly greater after cola than after chocolate milk, both immediately after preload intake (P=0.008, P=0.01, respectively) and 30 minutes afterwards (P=0.004, P=0.01, respectively). There was NS difference (P=0.42) in ad libitum lunch intake after ingestion of chocolate milk (3,145±1,268kJ) compared with cola (3,286±1,346kJ). The authors concluded that ingestion of chocolate milk increased subjective ratings of satiety and fullness compared with cola and decreased hunger and prospective consumption, but that this enhanced satiety did not translate into differences in ad libitum energy intake.

Hollis and Mattes, 2007 (neutral quality), a non-randomized crossover trial conducted in the US, assessed the effect of daily intake of one or three portions of dairy foods on energy intake and appetite. Subjects had seven days in the first treatment period of low or high dairy intake, a washout period of seven days and then seven days of the other treatment option; in the low-dairy phase, subjects could choose white or chocolate milk, yogurt or hard cheese, while in the high-dairy phase, subjects were required to have one serving of milk, one of yogurt, and one of hard cheese. Handheld devices were used to record appetite. Sixty subjects were enrolled in the study and 58 completed (28 males, 30 females, aged 18 to 50 years). Overall energy intake increased by 209 kcal per day in the high-dairy treatment period [F (1, 52) = 28.088, P<0.05], but there were NS differences noted for hunger, satiety, desire to eat or thoughts of food in any treatment groups. The authors concluded that increasing dairy consumption from one to three portions each day led to increased energy intake.

Pregnancy

Olsen et al, 2007 (neutral quality), a prospective cohort study, conducted in Denmark, examined whether milk consumption during pregnancy is associated with greater infant size at birth in the Danish National Birth Cohort (1996 to 2002). Dietary intake was assessed through FFQs during one month of mid-pregnancy, and birth outcomes were ascertained through registry linkages. A total of 70,187 mothers completed the FFQ; after application of exclusion criteria, 50,117 mother-infant pairs were included in the analysis (mean age of mothers = 29.1±4.3 years). Mean consumption of milk was 3.1±2.0 glasses per day. Milk consumption was inversely associated with the risk of small-for-gestational age (SGA) birth and directly with both large-for-gestational age (LGA) birth and mean birth weight (P<0.001). Comparing women drinking more than six glasses of milk per day with those not drinking milk, the OR for SGA was 0.51 (95% CI: 0.39, 0.65) and for LGA was 1.59 (95% CI: 1.16, 2.16). The increment in mean birth weight was 108 g (95% CI: 74, 143).

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Author, Year, Study Design, Class, Rating	**Participants**	**Description of Study Design**	**Outcomes**
Azadbakht L, Mirmiran P et al, 2005 Study Design: Cross-Sectional Study Class: D Rating:	N=1,476 participants (representative sample) randomly selected from the Tehran Lipid and Glucose Study, including 861 subjects aged 18 to 74 years. Final N=827 (357 men, 470 women) after application of exclusion criteria. Location: Tehran, Iran.	Cross-sectional study that ascertained the relation between dairy consumption and metabolic syndrome in a population-based sample of adults. Dairy consumption was assessed through a 168-item semi-quantitative FFQ and subjects were categorized into quartiles of intake. Measurements relevant to the diagnosis of metabolic syndrome were taken, such as height, weight, WC, BP and fasting blood samples for glucose and lipid concentrations.	Mean consumption of milk, yogurt and cheese was 0.7±0.2, 1.06±0.6, and 0.9±0.3 servings per day, respectively (butter and ice cream not included in analysis due to ↑ fat content). Participants in the fourth quartile of dairy intake (more than 3.1 servings per day) had a lower BMI than did those in the three lower quartiles (P<0.01). Subjects in the highest quartile of dairy consumption had ↓ odds of having enlarged WC (OR by quartile: 1, 0.89, 0.74, 0.63, P<0.001). These values became weaker after adjustment for calcium intake.

Beydoun et al 2008 Study Design: Cross-sectional Study Class: D Rating:	Out of 17,061 subjects >18 years (8,970 women and 8,091 men) with complete demographic data, 4,519 subjects had complete data on dietary intake and metabolic outcomes. Sample sizes ranged from 4,519 for metabolic syndrome to 14,618 for obesity. Location: United States.	Cross-sectional analysis of merged NHANES data from 1999 to 2004, assessed the association between consumption of dairy and related nutrients and obesity, central obesity and the metabolic syndrome. Included subjects had complete data on dietary intake (assessed from 24-hour recall data) and metabolic outcomes, such as weight, height, WC, BP and laboratory values (FBG, TG stores and HDL-C).	Multivariate logistic regression models suggested that there was an overall net increase of 5% in prevalence of central obesity for each dairy serving among men ($P<0.10$). Whole milk was weakly and negatively associated with the prevalence of central obesity, whereas low-fat milk had the opposite effect ($P<0.05$ for both). Yogurt was associated with ↓ BMI and WC ($P<0.05$ for both); in contrast, cheese was positively associated with BMI and WC ($P<0.05$ for both). In addition, large ethnic disparities existed for intakes of dairy and calcium, and for all metabolic outcomes, leading the authors to conclude that the health effects of dairy products and related nutrients are complex and may not be uniform across the population.

Bowen J, Noakes M et al, 2005 Study Design: Randomized Controlled Trial Class: A Rating:	N=50 (30 women, 20 men). Age: 25 to 64 years. Location: Australia.	RCT to compare the effects of two isocaloric, energy-restricted high-PRO diets that differ in dietary calcium and PRO source on weight ↓ and body composition. The intervention diets were a high dairy PRO/high-calcium (DP, 2,400mg calcium a day) diet and a high mixed PRO/moderate calcium (MP, 500mg calcium a day) diet followed by a 12-week energy restriction phase, followed by a four-week energy balance phase.	After 16 weeks, subjects showed significant ↓ in total weight (-9.7±3.8kg), fat mass (-8.3±0.4 kg) and lean mass (-1.6±0.3kg), but NS differences between the two diet groups.
Brooks et al 2006 Study Design: Cross-sectional Study Class: D Rating:	1,306 young adults from the Bogalusa Heart Study (374 white males, 578 white females; 131 black males, 223 black females). Mean age: 29.7 years. Location: United States.	Cross-sectional analysis of data from the Bogalusa Heart Study, examining the association between intake of calcium and dairy products and overweight and obesity in a biracial sample of young adults. Calcium intake and low-fat dairy product consumption was assessed through the Youth and Adolescent Questionnaire, a self-administered, semi-quantitative FFQ and overweight status was measured through BMI, WHR and WC.	Intakes of dairy products were significantly ↑ among blacks than whites (P<0.05), and females had significantly ↓ intakes of dairy products than males (P<0.05). NS associations were found between dairy product consumption, calcium intake and overweight, defined by BMI or WC; however, in white males, there was a significant inverse association between calcium intake, low-fat dairy product consumption and WHR.

Dove ER, Hodgson JM et al, 2009 Study Design: Randomized controlled trial with cross-over design Class: A Rating:	N=34 (13 men, 21 women). Mean age: 55.1±12.5 years. Mean BMI: 32.4±3.4kg/m^2. Location: Australia.	RCT with cross-over design. Participants consumed 600ml (1,062kJ each) of either skim milk or fruit drink with a fixed-energy breakfast (1,923kJ). Satiety was measured using visual analog scales (VAS) at breakfast (T=0), throughout the morning (T=30, 60, 120, 180, 210 and 240 minutes), and immediately after lunch (T=270 minutes). Lunch was provided four hours after breakfast (T=240 minutes), from which subsequent energy intake was assessed.	Participants consumed significantly less energy at lunch after consuming skim milk (mean: 2432 kJ; 95% CI: 2160, 2704 kJ) than after consuming the fruit drink (mean: 2658 kJ; 95% CI: 2386, 2930 kJ), with a mean difference of ~8.5% ($P<0.05$). Ratings of satiety were higher throughout the morning after consumption of skim milk than after consumption of the fruit drink ($P < 0.05$), with the differences becoming larger over the four hours ($P<0.05$).
Harper A, James A et al, 2007 Study Design: Randomized crossover design Class: A Rating:	N=22 men. Mean age: 23±1.8 years. Mean BMI: 22.2±1.5kg/m^2. Location: Denmark.	A randomized cross-over design study to compare the effect on appetite and energy intake of consuming either a sugar-sweetened beverage (cola) or chocolate milk drink. The test drinks were 500ml cola or chocolate milk (both 900kJ) and were ingested 30 minutes before an ad libitum lunch. Visual analogue scales were used to record	Satiety and fullness ratings were significantly greater (P=0.0007, P=0.0004, respectively) 30 minutes after chocolate milk than after cola. Ratings of prospective consumption and hunger were significantly greater after cola than after chocolate milk, both immediately after preload intake (P=0.008, P=0.01, respectively) and 30

		satiety every 30 minutes on the test days. Energy intake at lunch was calculated using weighed food intakes.	minutes afterwards (P=0.004, P=0.01, respectively). There was NS difference (P=0.42) in ad libitum lunch intake after ingestion of chocolate milk (3,145±1,268kJ) compared with cola (3,286±1,346kJ).
Hollis et al 2007 Study Design: Nonrandomized Crossover Trial Class: C Rating:	N=60 subjects enrolled. N=58 completed (28 males, 30 females). Age: 18 to 50 years. Location: United States.	Non-randomized crossover trial assessing the effect of daily intake of one or three portions of dairy foods on energy intake and appetite. Subjects had seven days in the first treatment period of low or high dairy intake, a washout period of seven days and then seven days of the other treatment option. In the low-dairy phase, subjects could choose white or chocolate milk, yogurt or hard cheese. While in the high-dairy phase, subjects were required to have one serving of milk, one of yogurt and one of hard cheese. Handheld devices were used to record appetite.	Overall energy intake ↑ by 209kcal per day in the high-dairy treatment period [F (1, 52) = 28.088, P<0.05], but NS differences noted in hunger, satiety, desire to eat or thoughts of food in any treatment groups. The authors concluded that increasing dairy consumption from one to three portions each day led to ↑ energy intake.

Houston et al 2008 Study Design: Cross-sectional Study Class: D Rating:	10,872 NHANES III participants had complete data and were included in the analysis. Age: 25 to75 years. Location: United States.	Cross-sectional study examining the association between the frequency of cheese consumption and several CVD risk factors, including measures of body fat, blood lipids, BP and blood glucose, using data from NHANES III. Cheese consumption (combined full and low-fat) was assessed through FFQ asking one question about cheese and two questions about the consumption of foods containing large amounts of cheese.	BMI and WC were significantly higher among men ($P<0.05$), but not among women, in the highest cheese consumption category (30 + servings a month) compared to non-consumers. More frequent cheese consumption was associated with a slightly worse body composition in men; however, there appeared to be less of an association between consumption and body composition in women.
Lanou AJ and Barnard ND, 2008 Study Design: Meta-analysis or Systematic Review Class: M Rating:	18 studies examined the effect of dairy products (seven studies; 330ml to four servings a day; three months to two years in length; N=28 to 757) or calcium (11 studies; 300 to 1,200mg calcium a day; six months to three years in length; N=84 to 162) in the absence of energy restriction in children and adolescents. 20 studies examined the effect of dairy products (10 studies; 12 weeks to three years in length; N=34 to 204) or calcium (10 studies; 1,000 to 1,200mg calcium a day; four months to seven years in length; N=37 to 36,282) in the absence of	A systematic review was done to evaluate the body of evidence on the effect of dairy product or calcium intake, with or without energy restriction, on body weight or adiposity. Studies were identified using a MEDLINE search (keywords: milk, dairy, calcium, weight, BMI, body fat) of clinical trials published between 1966 and 2007.	Of 38 studies, 37 showed no effect of dairy product or calcium intake in the absence of energy restriction on weight in adults or children. Of 11 studies, seven found no effect and four found a significant positive association between dairy or calcium and weight ↓ with energy restriction. 15 of 16 clinical trials showed no difference in body fat Δ between ↑ and ↓ consumers of dairy or calcium, while one study found ↑ fat

	energy restriction in adults. 11 studies examined the effect of dairy products (500 to 2,400mg calcium a day or two to four servings a day; 12 to 48 weeks in length; N=29 to 72) or calcium (1,200mg to 1g calcium a day; one month to 25 weeks in length; N=62 to 100) with energy restriction in adults.		loss among high-dairy consumers compared to low-dairy consumers.
Marques-Vidal et al 2006 Study Design: Cross-sectional Study Class: D Rating:	N=37,513 subjects (17,771 males, 19,742 females). Mean age: 47.8 years males; 50.3 years females. Location: Portugal.	Cross-sectional study assessing the relationship between milk intake and BMI status using a representative population sample from the Portuguese National Health Interview Survey 1998 to 1999 database. Average daily milk intake was calculated by a FFQ that also assessed the average volume of one serving; height and weight were self-reported.	In men, milk intake was inversely related to BMI ($R=-0.10$, $P<0.001$), whereas the relationship in women was weaker ($R=-0.06$, $P<0.001$). After adjustment for confounding variables, milk intake decreased with increasing BMI ($P<0.001$).
Mirmiran P, Esmaillzadeh A et al, 2005 Study Design: Cross sectional study Class: D Rating:	N=462 (223 men and 239 women). Age: 38±15 years men; 32±13 years women. BMI: 24.8±4.6kg/m^2 men; 25.3±5.3kg/m^2 women. Location: Tehran, Iran.	Daily dairy consumption was determined using 24-hour dietary recalls and a FFQ. Subjects were stratified into four quartiles based on dairy intake: 1) <1.6 2) 1.6 to <2.2 3) 2.2 <three	Mean consumption of dairy products was 3.7±1.0 and 2.9±1.2 servings per day in men and women, respectively. There was a significant inverse correlation between the servings of dairy consumed per day and BMI after controlling for age.

		4) >three.	physical activity, energy, CHO, dietary fiber, PRO and fat intake (R=-0.38, P<0.05). After adjustment for potential confounding variables, men and women in the top quartile of dairy consumption had lower chances for being overweight (OR=0.78; 95% CI=0.43, 0.92 for men and OR=0.89; 95% CI=0.53, 0.95 for women) and obese (OR=0.73; 95% CI=0.40, 0.83 for men and OR=0.69; 95% CI=0.34, 0.80 for women) compared to those in the first quartile.
Murakami K, Okubo H et al, 2006 Study Design: Cross-Sectional Study Class: D Rating:	N=1,905 women. Age: 18 to 20 years. Mean BMI: 20.8±2.6kg/m^2. Location: Japan.	A cross-sectional analysis was done to examine the associations between dairy product and calcium intake and BMI in young Japanese women. Dietary habits during the previous month were assessed by using a validated, self-administered diet history questionnaire (DHQ). Body weight and height were self-reported as part of the DHQ.	Mean estimated intakes were 268±93mg per 1,000kcal for calcium and 80±63g per 1,000kcal for dairy products. There were NS associations between BMI and calcium or dairy product intake in this study.

		BMI was computed as weight (kg) divided by the square of height (m).	
O'Neil CE, Nicklas TA et al, 2009 Study Design: Cross-Sectional Study Class: D Rating:	N=609 women (33% Hispanic, 43% African American, 24% white). Age: 30.0±0.2 years. BMI: 30.8±0.3kg/m^2. 58% completed high school or less; 46% married. Subjects were divided into groups based on beverage consumption: 1) Low milk, high sweetened beverage (SB) (N=170) 2) High milk, low SB (N=170) 3) Low milk, low SB (N=134) 4) High milk, high SB (N=135). Location: United States.	Cross-sectional data was used to assess the association of milk and SB consumption with weight, nutrient intake and dietary adequacy in a multiethnic population of Head Start mothers. Dietary intake was assessed via three 24-hour dietary recalls. Height and weight was measured twice on each participant and BMI calculated as kg/m^2.	Mean BMI did not differ between the four beverage consumption groups. Women in the high milk, low SB group had ↑ mean intakes of vitamins A, D, and B_6; riboflavin; thiamin; folate; phosphorus; calcium; iron; magnesium; and potassium ($P<0.0125$), when compared with the other beverage consumption groups. Mean Adequacy Ratio (a measure of overall dietary adequacy) was highest in the high milk/low SB (71.8 ± 0.8) and lowest in the low milk/high SB (58.4 ± 0.8) consumption groups ($P<0.0125$).
Olsen SF et al 2007 Study Design: Prospective Cohort Study Class: B Rating:	N=70,187 mothers completed the FFQ. N=50,117 mother-infant pairs included in analysis after application of exclusion criteria. Mean age of mothers: 29.1±4.3 years.	Prospective cohort study examining whether milk consumption during pregnancy is associated with greater infant size at birth in the Danish National Birth Cohort (1996 to 2002). Dietary intake was assessed through FFQs	Mean consumption of milk was 3.1±2.0 glasses per day. Milk consumption was inversely associated with the risk of SGA birth and directly with both LGA birth and mean birth weight ($P<0.001$).

	Location: Denmark.	assessed through FFQ during one month of mid-pregnancy; birth outcomes were ascertained through registry linkages.	Comparing women drinking more than six glasses of milk per day with those not drinking milk, the OR for SGA was 0.51 (95% CI: 0.39, 0.65) and for LGA was 1.59 (95% CI: 1.16, 2.16). The increment in mean birth weight was 108g (95% CI: 74, 143).
Rajpathak SN, Rimm EB et al, 2006 Study Design: Prospective Cohort Study Class: B Rating:	N=19,615 men. Age: 40 to 75 years. Mean BMI: 25.2 kg/m^2. Health Professionals Follow-up Study. Location: United States.	Data from a prospective cohort study to evaluate the association between calcium and dairy intakes and 12-year weight Δ in US men. Dietary intake during the preceding year was assessed in 1986 using a FFQ, which also collected information on the use of calcium and multivitamin supplements.	Results of a multivariate analysis adjusted for potential confounders showed that neither baseline nor Δ in total calcium intake was significantly associated with weight Δ. NS association between weight and dietary, dairy or supplemental calcium when each calcium source was evaluated separately. Men with the largest ↑ in total dairy intake gained slightly more weight (3.14±0.11kg) than did men with the largest ↓ in dairy intake (2.57±0.13kg) (P<0.001). This association was primarily due to an ↑ in high-fat dairy intake

			(P<0.001), as low-fat dairy intake was NS associated with weight Δ (P=0.19).
Rosell et al 2006 Study Design: Prospective Cohort Study Class: B Rating:	N=19,352 women. Mean age: 46.3±4.5 years at baseline. Swedish Mammography Cohort. Location: Sweden.	Prospective cohort study examining the association between changes in dairy product consumption and self-reported weight Δ over nine years. In 1987, dietary intake was measured with a 67-item FFQ, and in 1997, it was measured with an extended 96-item FFQ. Women were divided into four dairy product consumption groups (serving per day): 1) <one, no Δ at follow-up 2) <one, ↑ to >one at follow-up 3) >one, no Δ at follow-up 4) >one, ↓ to <one at follow-up.	Mean BMI at baseline was 23.7±3.5kg/m^2 and mean weight ↑ in the cohort was 0.33±0.63kg per year. Consistent consumption of >one serving of dairy products per day was inversely associated with weight gain. OR for consumption of >one serving per day of whole milk and sour milk was 0.85 (95% CI: 0.73, 0.99) and of cheese was 0.70 (95% CI: 0.59, 0.84), while NS associations were seen for the other three intake groups. The authors concluded that the association between the intake of dairy products and weight gain differed according to the type of dairy product and to the body weight status at baseline.
Snijder et al 2008 Study Design: Prospective Cohort Study	N=1,124 white men and women. Age: 50 to 75 years. Hoorn Study. Location: The Netherlands.	Prospective cohort study investigating the association between dairy consumption and 6.4-year Δ in weight and metabolic disturbances.	Linear regression analyses, using the continuous dairy variable as independent variable and the change in body composition or

Class: B Rating:		Average food intake was measured at baseline using a 92-item semi-quantitative FFQ. At baseline and follow-up, participants underwent an extensive physical examination that included measurement of weight and WC.	metabolic variables as dependent variables, revealed that baseline dairy composition was not associated with Δ in body composition or metabolic variables, neither after adjustment for potential confounders. In subjects with BMI<25kg/m^2, higher dairy consumption was significantly associated with an ↑ in BMI, WC and weight (data not shown).
Vergnaud et al 2008 Study Design: Prospective Cohort Study Class: B Rating:	N=2,267 subjects (1,022 women, 1,245 men) Mean age: 50.8±4.3 years women; 51.5±4.44 years men Supplementation en Vitamines et Mineraux Antioxidants (SU.VI.MAX) Study. Location: France.	Prospective cohort study investigating the relationship between dairy consumption and calcium intake with six-year Δ in body weight and WC. Anthropometric measurements were taken at the first (1995 to 1996) and last (2001 to 2002) clinical examinations and at least six 24-hour dietary records during the first 18 months were evaluated.	In overweight men only, six-year Δ in weight and WC were inversely associated with the dairy product consumption, especially milk (P=0.02 for both weight and WC Δ) and yogurt (P=0.01 for weight Δ, P=0.03 for WC Δ). Positive relations were found between milk consumption and WC Δ in overweight women, and between yogurt consumption and weight Δ in normal-weight women. The authors concluded that the associations between dairy product consumption and anthropometric

			changes differed according to sex, overweight status at baseline and type of dairy product.

Research Design and Implementation Rating Summary
For a summary of the Research Design and Implementation Rating results, click here.

Worksheets

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